Supersonic events in TR lines

Lucia Kleint

University of Applied Sciences and Arts
Northwestern Switzerland (FHNW)

Supersonic events in TR lines

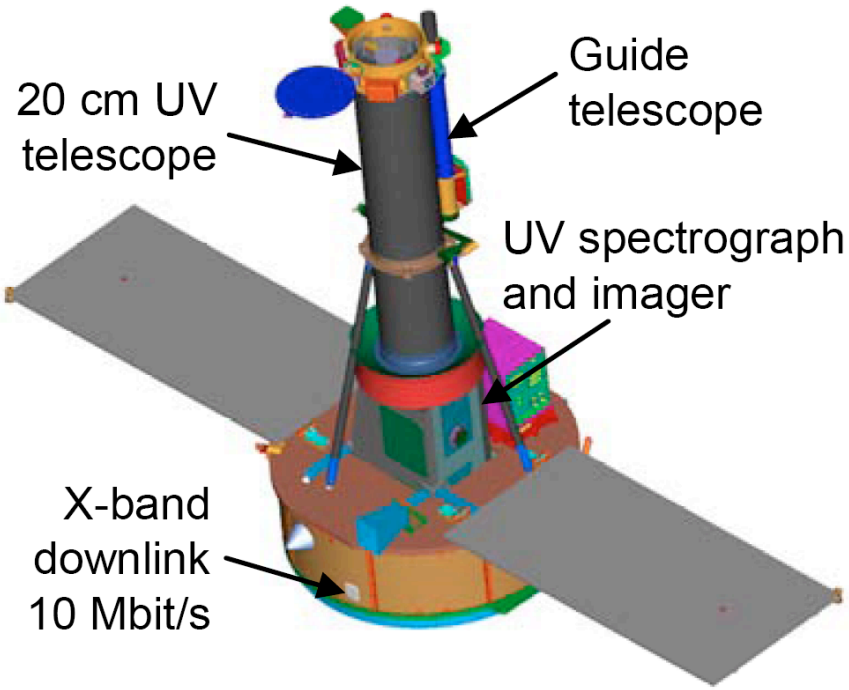
Lucia Kleint

ences and Arts
nd (FHNW)

Introduction

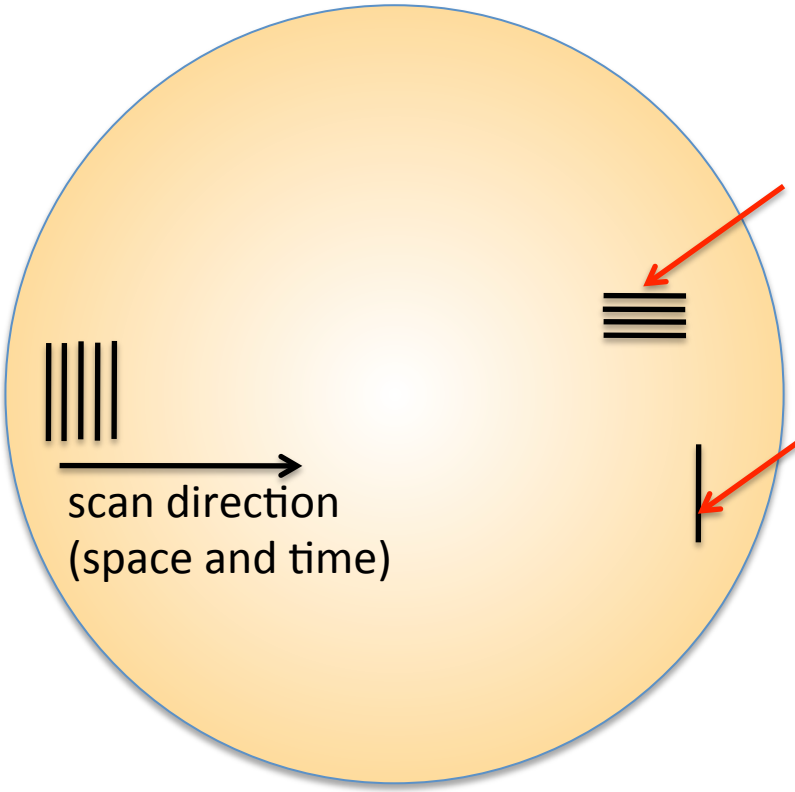
- Capabilities of IRIS
- IRIS observations of coronal rain on disk

IRIS



Images: Lockheed Martin Solar & Astrophysics Lab

IRIS Observing modes



any number of steps in
any direction

also possible: sit-and-stare
(with or without solar
rotation tracking)

rasters have 3 dimensions
(wavelength, position along slit,
scanning position)

IRIS Spectral lines

Table 4. Thermal coverage of IRIS spectrograph

Ion	Wavelength [Å]	Dispersion [mÅ pix^{-1}]	Log T [log K]	Passband	CEB
Mg II wing	2820	25.46	3.7 – 3.9	NUV	2
O I	1355.6	12.98	3.8	FUV 1	1
Mg II h	2803.5	25.46	4.0	NUV	2
Mg II k	2796.4	25.46	4.0	NUV	2
C II	1334.5	12.98	4.3	FUV 1	1
C II	1335.7	12.98	4.3	FUV 1	1
Si IV	1402.8	12.72	4.8	FUV 2	1
Si IV	1393.8	12.72	4.8	FUV 2	1
O IV	1399.8	12.72	5.2	FUV 2	1
O IV	1401.2	12.72	5.2	FUV 2	1
Fe XII	1349.4	12.98	6.2	FUV 1	1
Fe XXI	1354.1	12.98	7.0	FUV 1	1

n|i

IRIS Science

Example: Coronal Mass Ejection

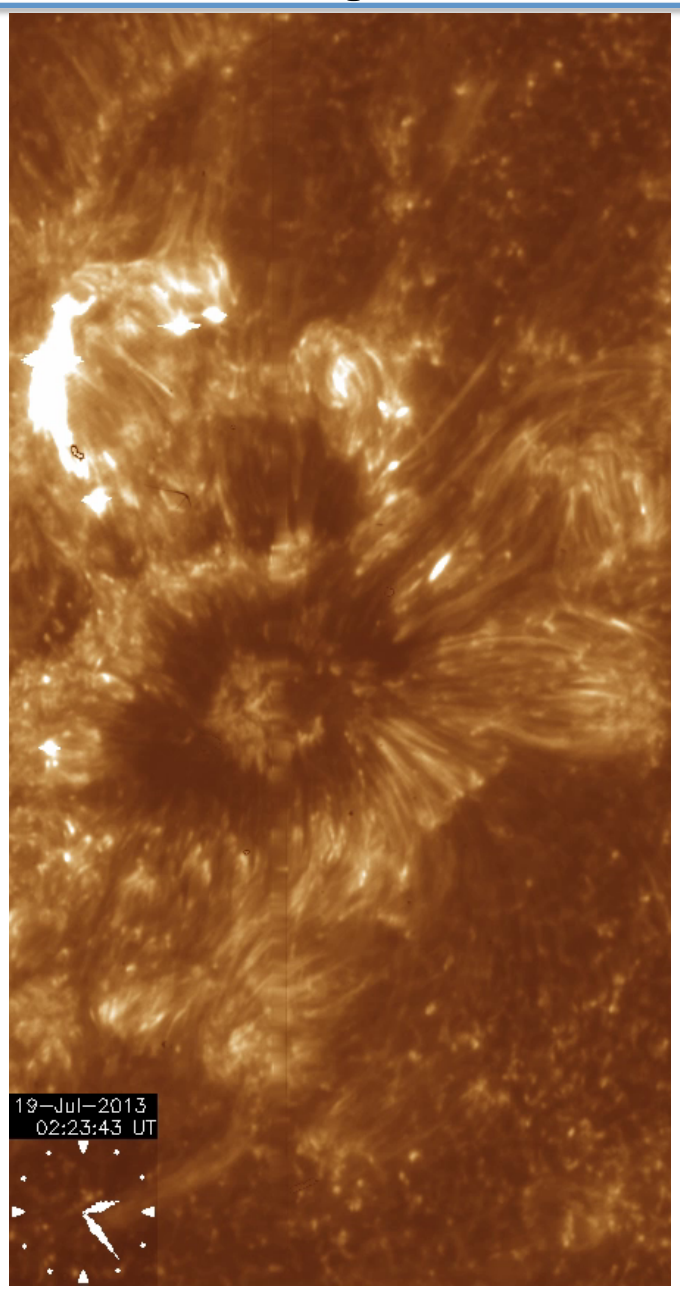
Supersonic downflows

Open questions:

- Early observations have shown supersonic flows near sunspots (with low spatial resolution). What are they? Can IRIS resolve more?

- How fast? Faster than gravity?

Supersonic downflows

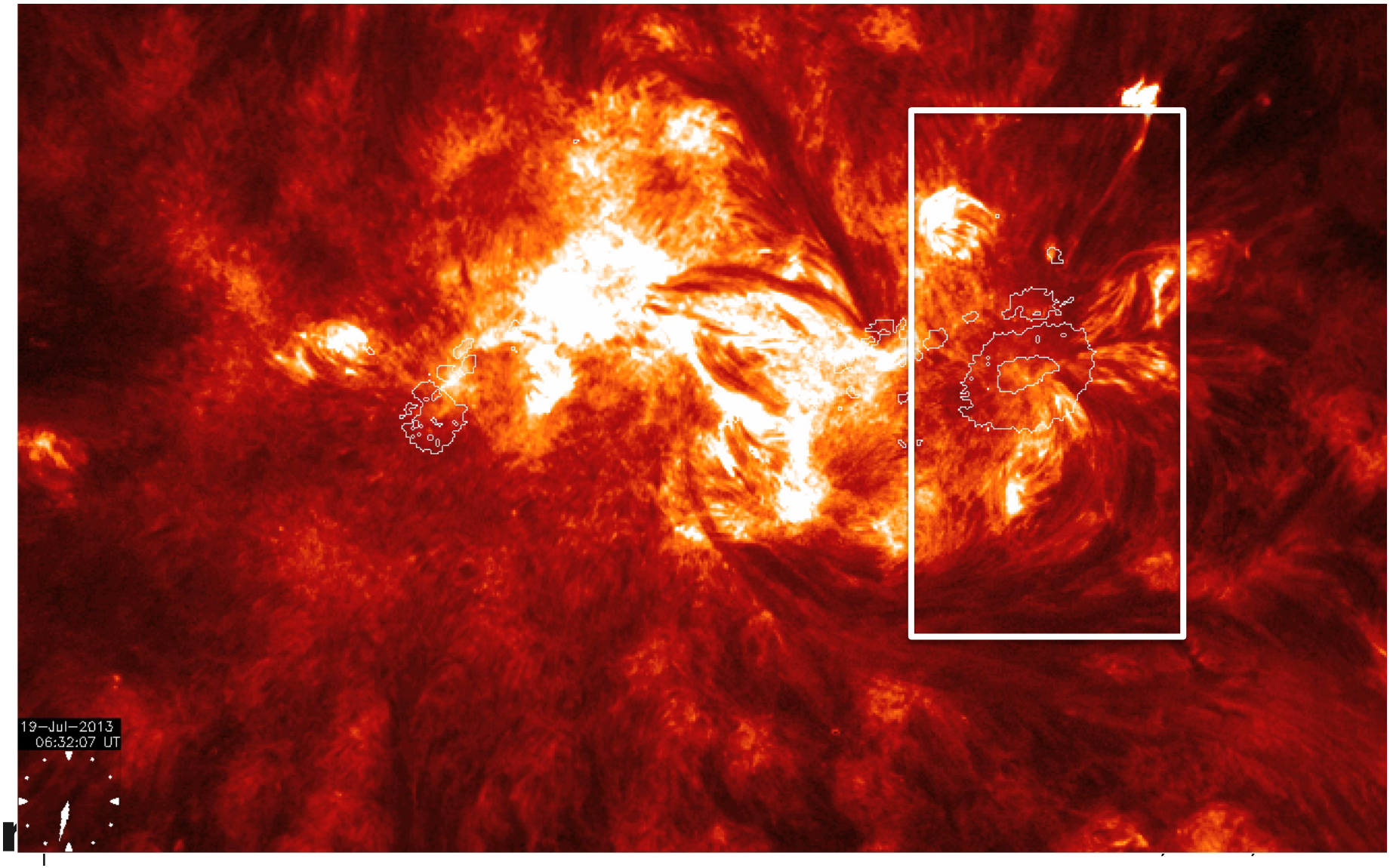


Observation on 2013-07-19

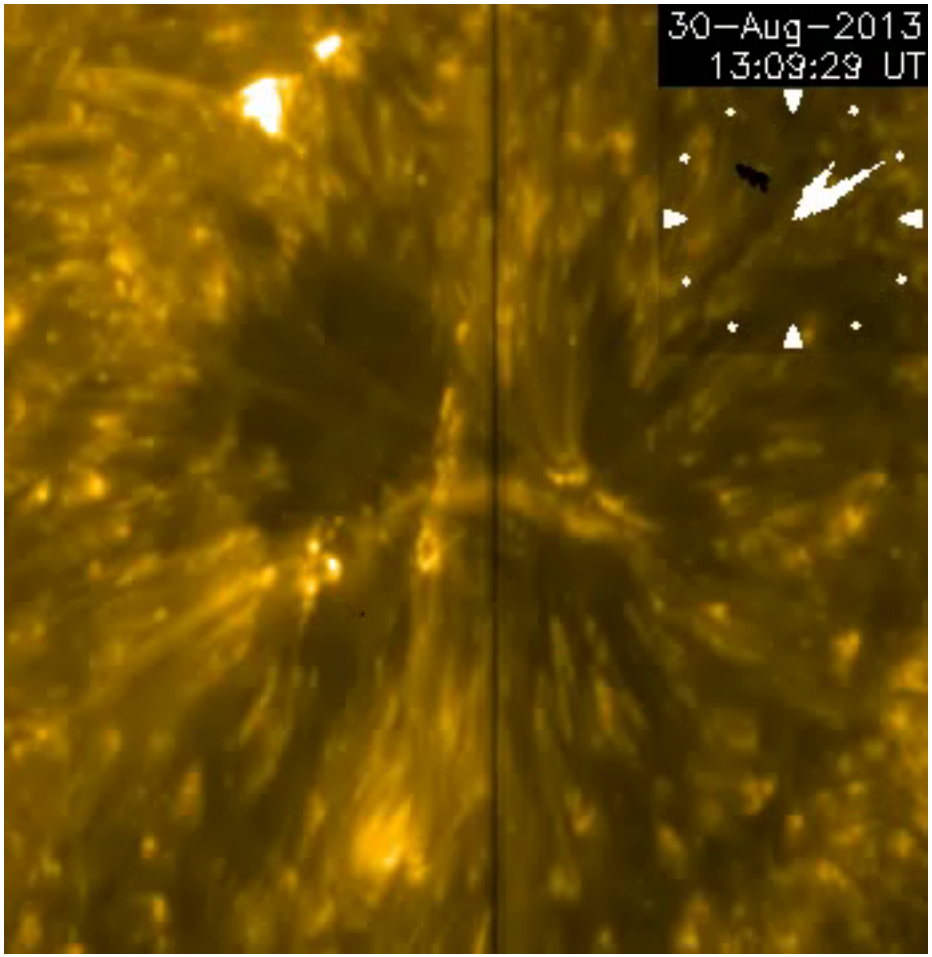
"string of pearls" forms.

Supersonic downflows

Observation on 2013-07-19, AIA 304.



Supersonic downflows

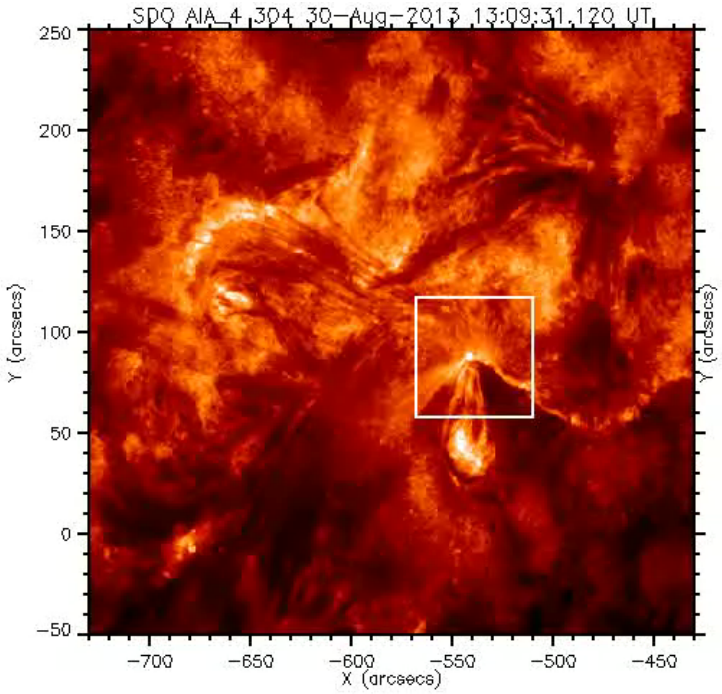


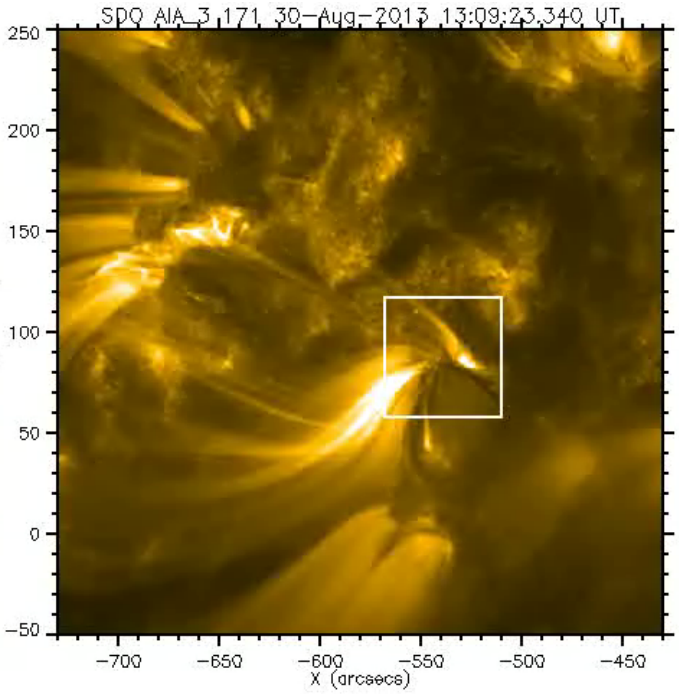
Observation on 2013-08-30

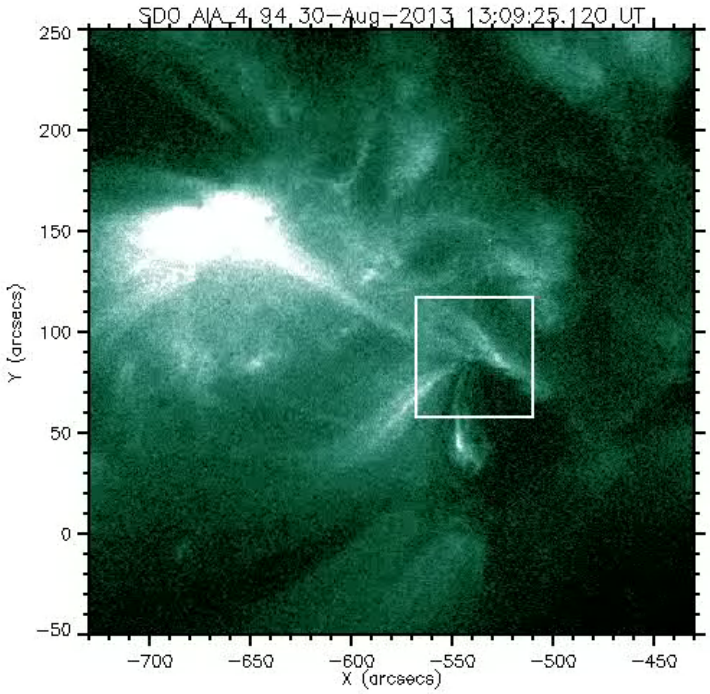
Plasma flow along loops.
Bright dots appearing.

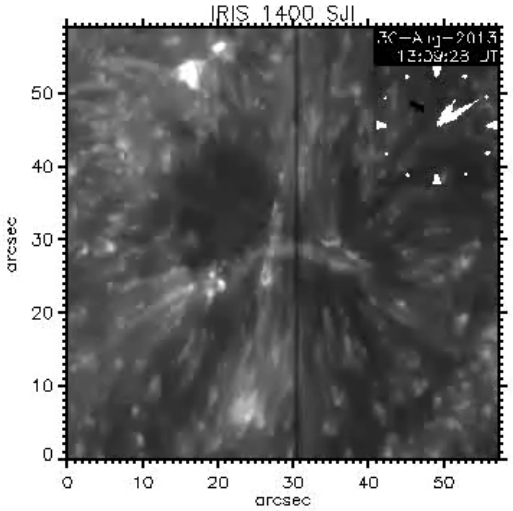
Introduction

O IV Si IV

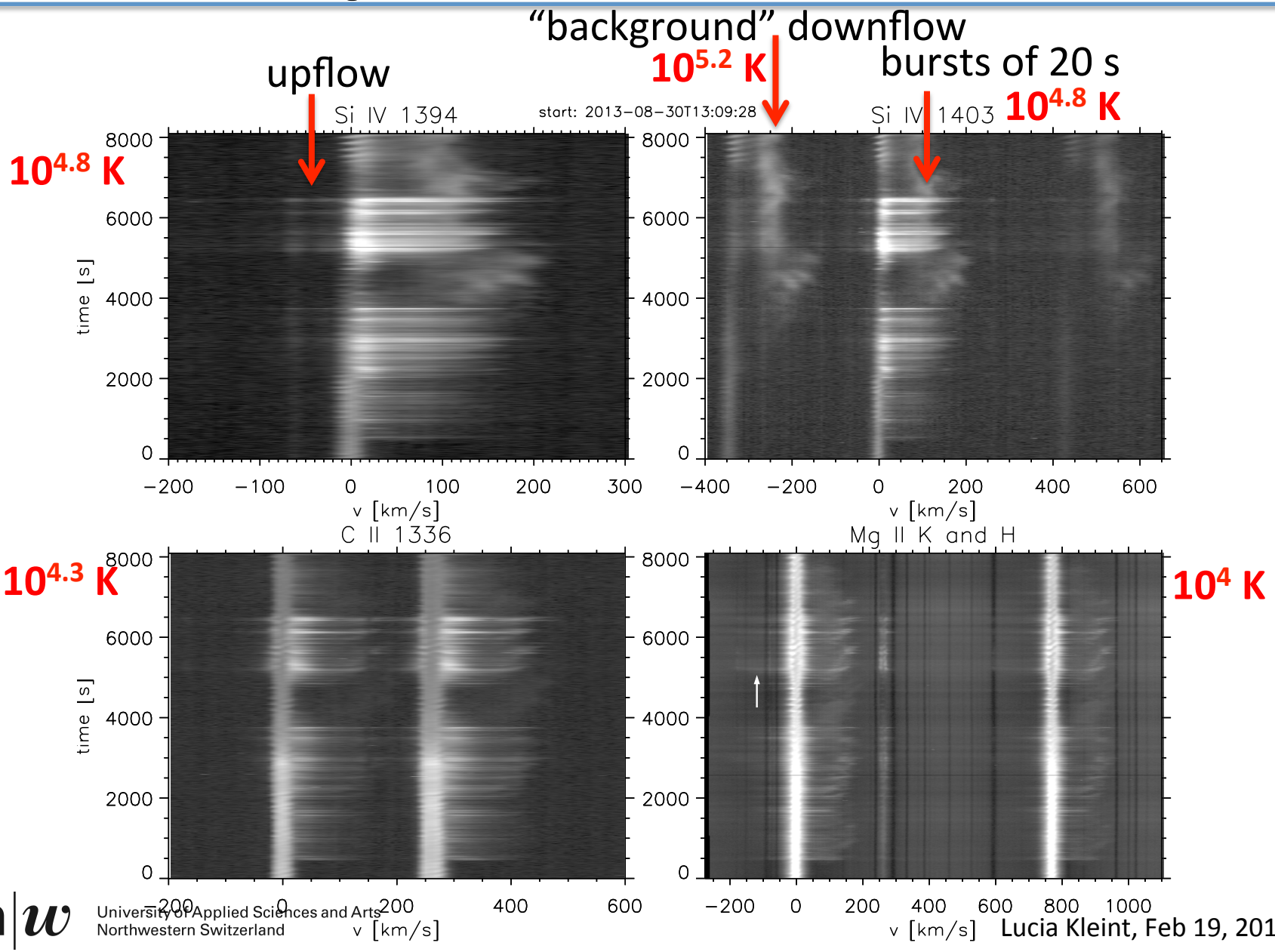

SDO AIA_4 304 30-Aug-2013 13:09:31.120 UT
Y (arcsecs)
X (arcsecs)


SDO AIA_3 171 30-Aug-2013 13:09:23.340 UT
Y (arcsecs)
X (arcsecs)

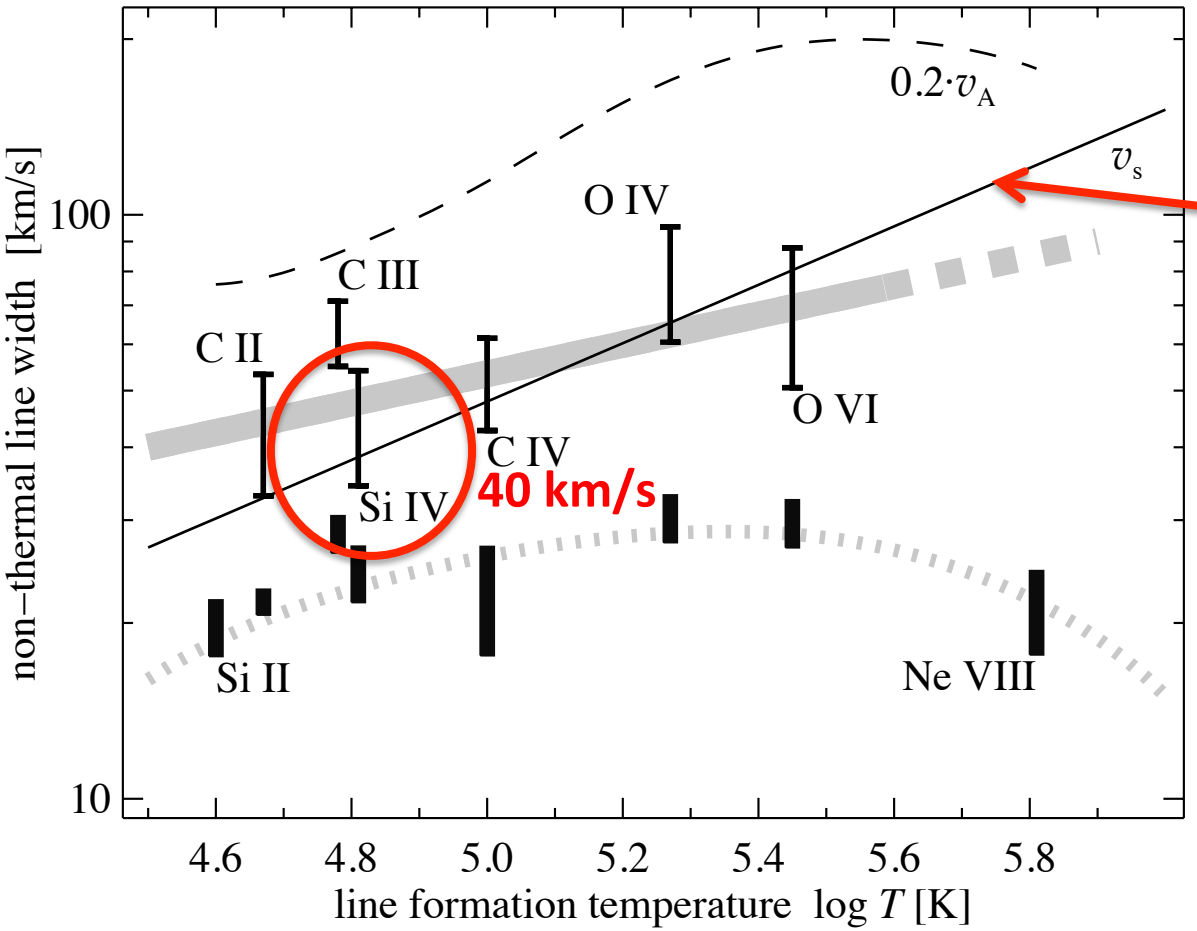

SDO AIA_4 94 30-Aug-2013 13:09:25.120 UT
Y (arcsecs)
X (arcsecs)


IRIS 1400 SJI
arcsec
arcsec

Supersonic downflows



Supersonic downflows



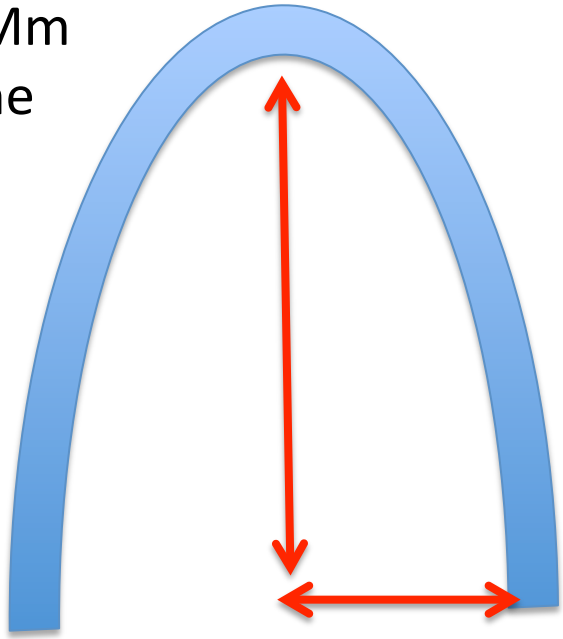
sound speed (assuming adiabatic approx.)

200 km/s is definitely supersonic

Peter (2001), A&A 374

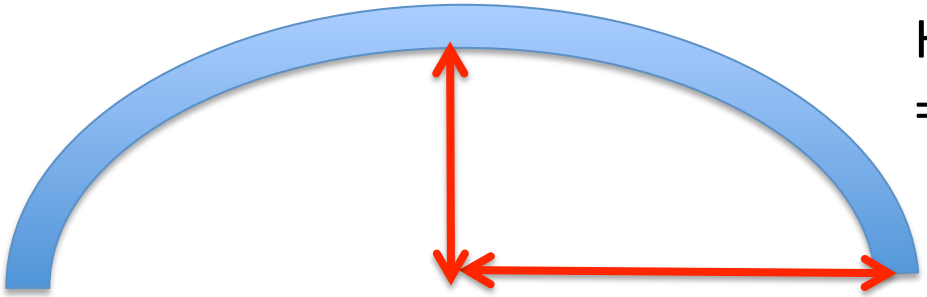
Faster than free fall?

Measured 50 Mm for half-baseline from AIA



$$v_s(s) = \sqrt{2 \int_0^s g_{\text{sun}} \cos\theta(s')ds'}.$$

Case 1:
twice as high as half-baseline
=> v_{max} = 180 km/s



Case 2:
Half as high as half-baseline
=> v_{max} = 145 km/s

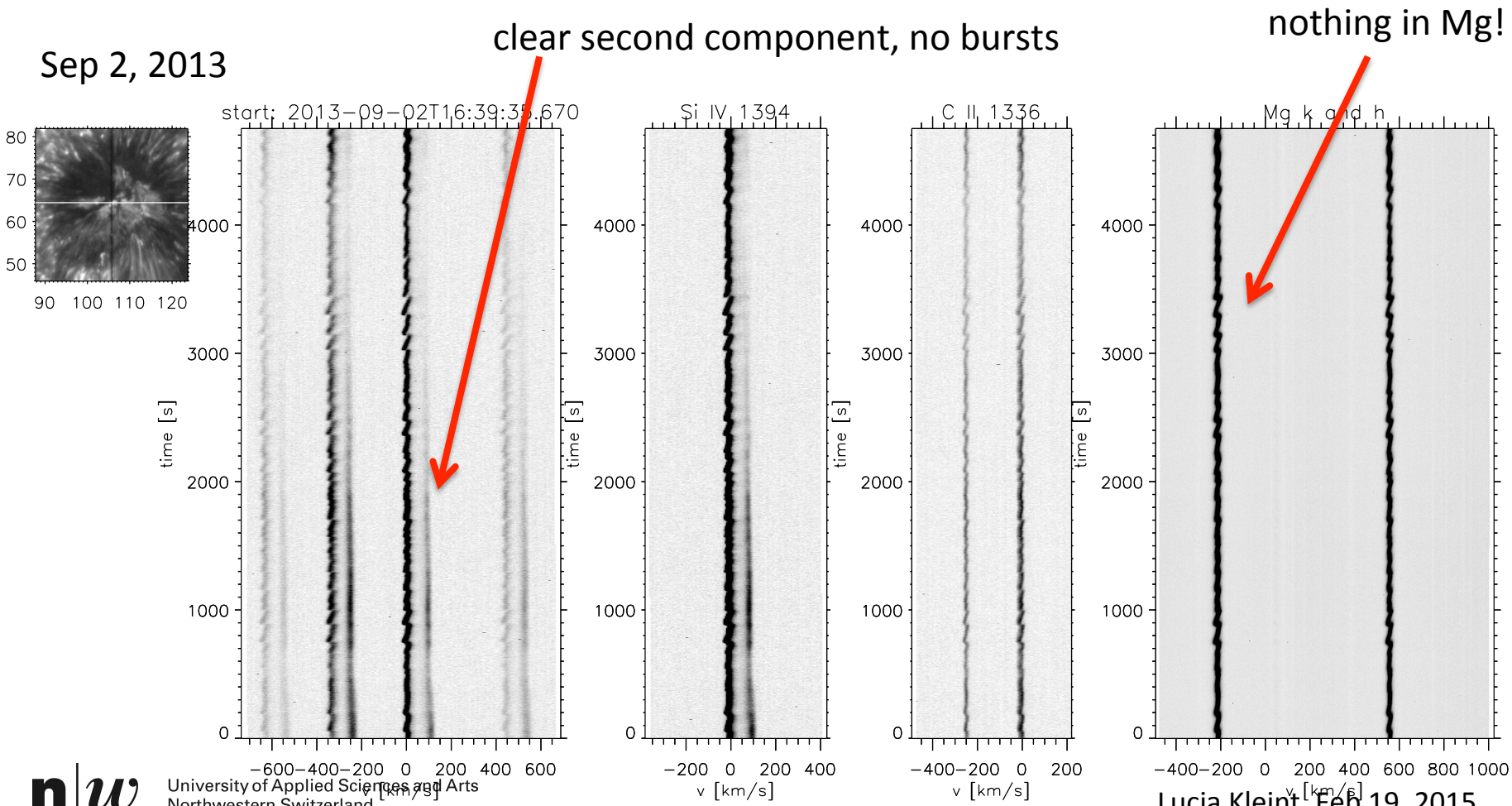
200 km/s is higher than gravity.

August 30, 2013 event

- **Supersonic downflows**: coronal rain hitting the sunspot at speeds of ~200 km/s.
- Lasts for whole observation (2 hours) with bursts of ~20 s, corresponding to brightenings in SJI
- No time lag between spectral lines (~5 s cadence)
- Heating in the TR.
- faster than gravity

How frequent are supersonic downflows?

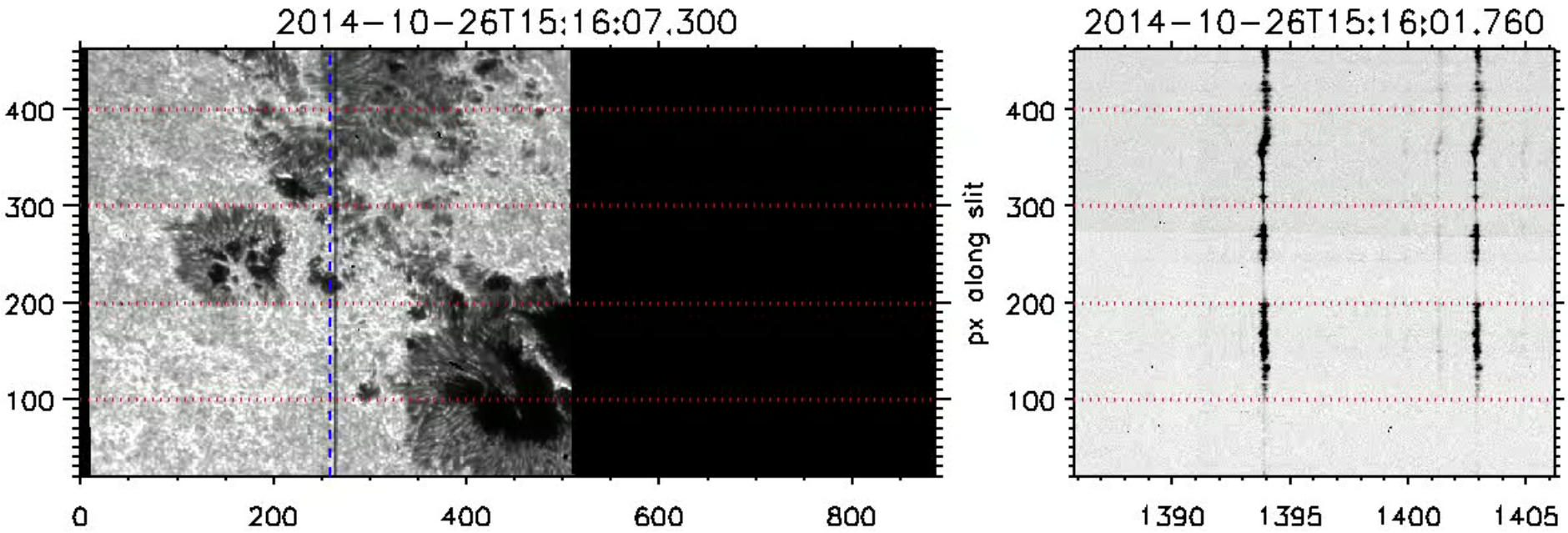
- **no trouble finding other examples, although limited number of suitable observations (fast cadence, ideally sit-and-stare, sunspots)**



How frequent are supersonic downflows?

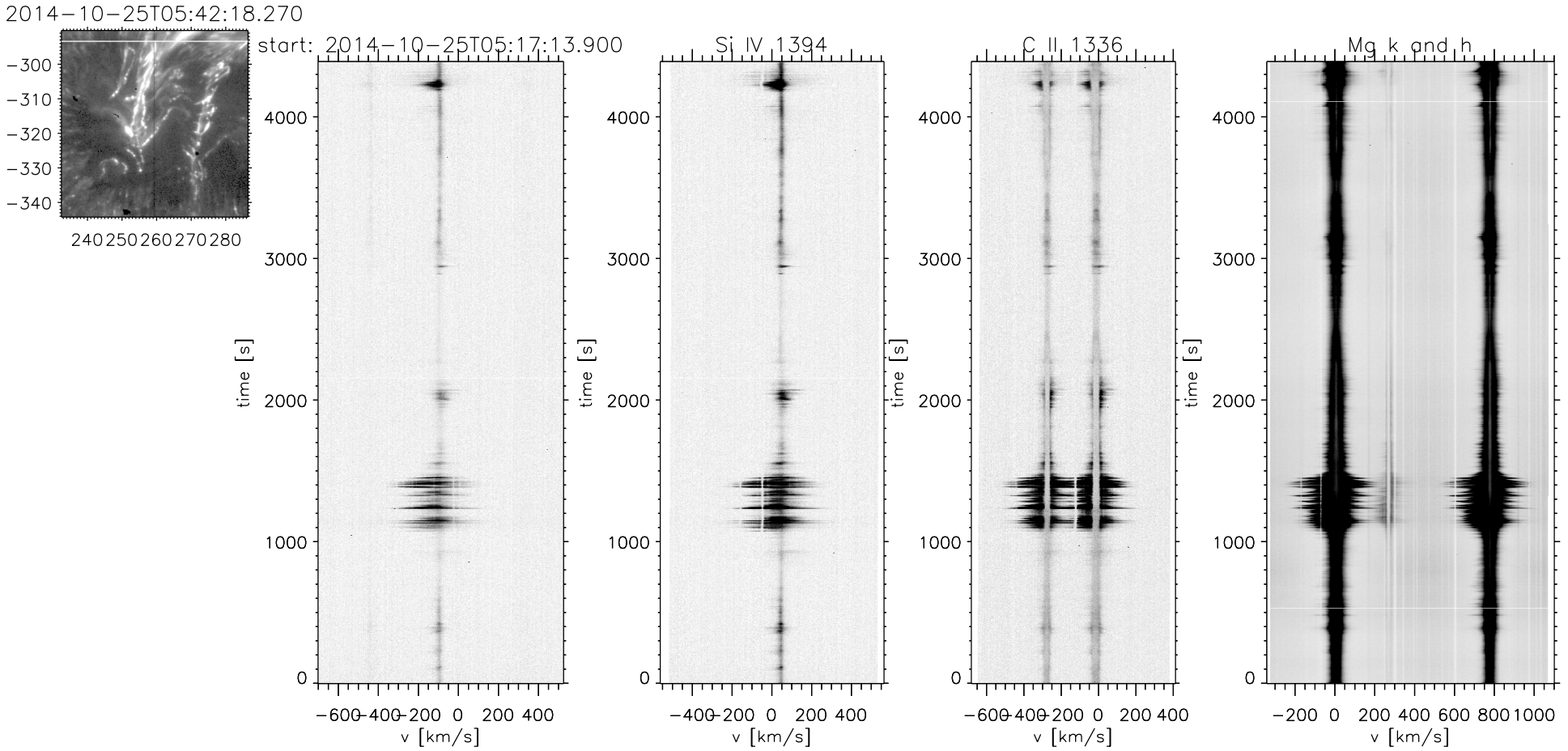
AR 12192 – largest spot since 1990

Inside spot: barely any spectral lines – spot probably too cold



AR 12192 – largest spot since 1990

Some very broad profiles, but no clear flows



Conclusions

- **Supersonic downflows**:
- visible in several, but not all sunspots – more statistics needed
- coronal rain hitting the sunspot at speeds of ~200 km/s.
- Can have bursts (in which case brightenings in SJI are visible) or be steady
- Can be faster than gravity.